1.1 Introduction

This specification provides for the design, manufacture with approved QAP, factory acceptance testing, packing and transporting to site, installation and commissioning, conducting site performance test as per IEC for SF6 gas insulated switchgear bays complete with all necessary control and instrumentation devices.

1.2 General

The SF6 gas insulated metal enclosed switchgear shall be totally safe against inadvertent touch of any of its live constituent parts. It should be designed for indoor application with meteorological conditions at site (winter 3degC to 14 deg C and Summer 31 deg C to 46 deg C, seismic zone: IV). All parts of the switchgear should be three phase enclosed for 220kV GIS.

The arrangement of gas sections or compartments shall be such as to facilitate future expansion of incomer bay with any make on either end without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays.

The design should be such that all parts subjected to wear and tear are easily accessible for maintenance purposes. The equipment offered shall be protected against all types of voltage surges and any equipment necessary to satisfy this requirement shall be deemed to be included. The required overall parameters of GIS are as follows:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Technical Particulars</th>
<th>220kV System</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated Voltage</td>
<td>245 kV (rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 HZ</td>
</tr>
<tr>
<td>c)</td>
<td>Grounding</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Rated Power frequency withstand Voltage (1 min) line to earth</td>
<td>460 kV (rms)</td>
</tr>
<tr>
<td>e)</td>
<td>Impulse withstands BIL 1.2/50/mic. Sec) Line to earth</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td>f)</td>
<td>Switching impulse voltage (250/2500 mic-sec)</td>
<td>-</td>
</tr>
<tr>
<td>g)</td>
<td>Rated short time withstand current (1 sec)</td>
<td>40 kA (rms)</td>
</tr>
<tr>
<td>h)</td>
<td>Rated peak withstand current</td>
<td>100 kA (peak)</td>
</tr>
<tr>
<td>i)</td>
<td>Guaranteed maximum gas losses or complete installation as well as for all individual sections in%</td>
<td>As per IEC- 62271-203</td>
</tr>
<tr>
<td>j)</td>
<td>Seismic level</td>
<td>Zone-IV, as per IS-1893,Year-2002</td>
</tr>
</tbody>
</table>

The metal-enclosed gas insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the IEC- 62271-203/IEC-62271-200 publications including their parts and supplements as amended or revised to date.
2.0 Reference Standards

The metal-enclosed gas-insulated switchgear, including the operating devices, accessories and auxiliary equipment forming integral part thereof, shall be designed, manufactured, assembled and tested in accordance with the following International Electro-technical Commission (IEC) standards including their parts and supplements as amended or revised till date:

IEC 62271-203     Gas Insulated metal-enclosed switchgear for rated voltages above 52KV.
IEC 60376     New sulphur hexafluoride
IEC 62271-100     High voltage alternating current Circuit breakers
IEC 60694     Common clauses for high voltage Switchgear and control-gear standards
IEC 62271-102     Alternating current disconnectors (isolators) and earthing switches.
IEC 61129     Alternating current earthing switches. Induced current switching
IEC 66044-1     Current transformers
IEC 66044-2     Voltage transformers
IEC 60137     Bushings for alternating voltages above 1000 V
IEC 60859     Cable connections for gas-insulated switchgear
IEC 60480     Guide to checking of sulphur hexafluoride taken from electrical equipment
IEC 60099-1/4     Non-linear resistor type arresters for AC systems
IEC 60439     Factory-built assemblies of low-voltage switchgear and control gear.
IEC 60427     Report on synthetic testing of high-voltage alternating current circuit breaker.
CIGRE-44     Earthing of GIS- an application guide. (Electra no.151, Dec’93)

The components and devices which are not covered by the above standards shall conform to, and comply with, the latest applicable standards, rules, codes and regulations of the internationally recognized standardizing bodies and professional societies as may be approved by the Purchaser. The manufacturer shall list all applicable standards; codes etc. and provide copies thereof for necessary approval.

In case the requirements laid down herein differ from those given in above standard in any aspect the switchgear shall comply with the requirements indicated herein in regard thereto.

3.0 Definitions

3.1 Assembly

Assembly refers to the entire completed GIS equipment furnished under contract.

3.2 Bay

Bay refers to the area occupied by one Circuit Breaker and associated equipments used to protect one feeder/line/ in single bus scheme as per the approved single line diagram of the purchaser.

3.3 Compartment
When used in conjunction with GIS equipment, compartment refers to a gas tight volume bounded by enclosure walls and gas tight isolating barriers.

3.4 Enclosure

When used in conjunction with GIS equipment, enclosure refers to the grounded metal housing or shell which contains and protects internal power system equipments (breaker, disconnecting switch, grounding switch, voltage transformer, current transformer surge arresters, interconnecting bus etc.)

3.5 Manual Operations

Manual operation means operation by hand without using any other source of Power.

3.6 Module

When used in conjunction with GIS equipment, module refers to a portion of that equipment. Each module includes its own enclosure. A module can contain more than one piece of equipment, for example, a module can contain a disconnecting switch and a grounding switch.

3.7 Reservoir

When used in conjunction with GIS equipment reservoir refers to a larger gastight volume.

4.0 General Design & Safety Requirement.

4.01 The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be such that maintenance on one busbar/compartment may be performed without de-energizing the adjacent busbar/feeders. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting of pressures developing within the enclosures under worst operating conditions.

4.02 The workmanship shall be of the highest quality and shall conform to the latest modern practices for the manufacture of high technology machinery and electrical switchgear.

4.03 The switchgear, which shall be of modular design, shall have complete phase isolation for 220kV GIS. The conductors and the live parts shall be mounted on high graded epoxy resin insulators. These insulators shall be designed to have high structural strength and electrical dielectric properties and shall be shaped so as to provide uniform field distribution and to minimize the effects of particle deposition either from migration of foreign particles within the enclosures or from the by-products of SF6 breakdown under arcing conditions.

4.04 Gas barrier insulators and support insulators shall have the same basis of design. The support insulators shall have holes on both sides for proper flow of gas.

4.05 Gas barrier insulators shall be provided so as to divide the GIS into separate compartments. They shall be suitably located in order to minimize disturbance in case of leakage or dismantling. They shall be designed to withstand any internal fault thereby keeping an internal arc inside the faulty compartment. Due to safety requirement for working on this pressurized equipment, whenever the pressure of the adjacent gas compartment is reduced, it should be ensured by the bidder that adjacent compartment would remain in service with reduced pressure. The gas tight barriers shall be clearly marked on the outside of the enclosures.

4.06 The material and thickness of the enclosures shall be such as to withstand an internal flash over without burn through for a period of 500 ms. The material shall be such that it has no effect of environment as well as from the byproducts of SF6 breakdown under arcing condition.
4.07 Each section shall have plug-in or easily removable connection pieces to allow for easy replacement of any component with the minimum of disturbance to the remainder of the equipment.

4.08 The material used for manufacturing the switchgear equipment shall be of the type, composition and have physical properties best suited to their particular purposes and in accordance with the latest engineering practices. All the conductors shall be fabricated of electrolytic grade (99.9% pure) copper tubes of cross-sectional area suitable to meet the normal and short circuit current rating requirements. The finish of the conductors shall be smooth so as to prevent any electrical discharge. The conductor ends shall be silver plated and fitted into finger contacts or tulip contacts. The contacts shall be of sliding type to allow the conductors to expand or contract axially due to temperature variation without imposing any mechanical stress on supporting insulators.

4.09 The enclosure shall be designed to withstand an external pressure of one atmosphere (with a 1.5 safety factor) with zero internal pressure absolute and be designed and tested to withstand an internal pressure of 1.5 times the design pressure. The enclosures shall be divided into several compartments or sections separated by gastight barriers permitting removal of a section or sections from service for maintenance without affecting adjacent sections. All the enclosures undergo hydraulic tests and leakage tests and comply with European pressure vessel code (CENELEC). Each pressure filled enclosure shall be designed and fabricated to comply with the requirements of the applicable pressure vessel codes and based on the design temperature and design pressures as defined in IEC-62271-203.

4.10 The manufacturer shall guarantee that the pressure loss within each individual gas-filled compartment shall not be more than half percent (0.5%) per year.

4.11 Each gas-filled compartment shall be equipped with static filters, density switches, filling valve and safety diaphragm. The filters shall be capable of absorbing any water vapour which may penetrate into the enclosures as well as the by-products of SF6 during interruption. Each gas compartment shall be fitted with separate non-return valve connectors for evacuating & filling the gas and checking the gas pressure etc.

4.12 The switchgear line-up when installed and operating under the ambient conditions shall perform satisfactorily and safely under all normal and fault conditions. Even repeated operations up to the permissible servicing intervals under 100% rated and fault conditions shall not diminish the performance or significantly shorten the useful life of the switchgear. Any fault caused by external reasons shall be positively confined to the originating compartment and shall not spread to other parts of the switchgear. The internal components shall be maintenance free for at least 10 years. Routine replacements of insulating gas shall not be required in intervals of less than ten years.

4.13 The thermal rating of all current carrying parts shall be minimum for one sec. for the rated symmetrical short-circuits current.

4.14 The switchgear shall be of the free standing, self-supporting with easy accessibility to all the parts during installation & maintenance with all high voltage equipment installed inside gas-insulated metallic and earthed enclosures. It shall be suitably sub-divided into individual arc and gas-proof compartments for 220kV GIS:
   a) Bus bars
   b) Intermediate compartment
   c) Circuit breakers
   d) Bus/Line disconnectors
   e) Voltage Transformers
   f) Gas Insulated bus section between GIS and XLPE cable
   g) Gas Insulated bus section between GIS & Condenser boosting

4.15 The arrangement of the individual switchgear bays shall be such as to achieve optimum space-saving, neat and logical arrangement and adequate accessibility to all external components.
It is required that the three phases of each switchgear bay be arranged side by side. The arrangement of the equipment offered must provide adequate access for operation, testing and maintenance (applicable for 220kV GIS).

4.17 **Local Control & Substation Automation System:**

Separate control cubicle including gas monitoring kiosk shall be provided for each bay which shall be installed near the switchgear for local control & monitoring of respective switchgear bay. Local control cubicle for GIS shall be equipped with suitable hardware & software for remote control operation and conform to the bay level controller as detailed in Section: Substation Automation System.

4.18 All the elements shall be accessible without removing support structures for routine inspections and possible repairs. The removal of individual enclosure parts or entire breaker bays shall be possible without disturbing the enclosures of neighboring bays.

4.19 It should be impossible to unwillingly touch live parts of the switchgear or to perform operations that lead to arcing faults without the use of tools or brute force.

4.20 All interlocks that prevent potentially dangerous mal-operations shall be constructed such that they can not be operated easily, i.e. the operator must use tools or brute force to over-ride them.

4.21 In general the contours of energized metal parts of the GIS and any other accessory shall be such, so as to eliminate areas or points of high electrostatic flux concentrations. For 220kV GIS, the surfaces shall be smooth with no projection or irregularities which may cause visible corona. No corona shall be visible in complete darkness which the equipment is subjected to specified test voltage. There shall be no radio interference from the energized switchgear at rated voltage.

4.22 The enclosure shall be of continuous design and shall meet the requirement as specified in clause no. 10 (special considerations for GIS) of IEEE- 80, Year- 2000. The enclosure shall be sized for carrying induced current equal to the rated current of the Bus. The conductor and the enclosure shall form the concentric pair with effective shielding of the field internal to the enclosure.

4.23 The fabricated metal enclosures shall be of Aluminium alloy having high resistance to corrosion, low electrical loses and negligible magnetic losses. All joint surfaces shall be machined and all castings shall be spot faced for all bolt heads or nuts and washers. All screws, bolts, studs and nuts shall conform to metric system. The other type of non-magnetic enclosures may be considered.

4.24 The breaker enclosure shall have provision for easy withdrawal of the interrupter assemblies. The removed interrupter assembly must be easily and safely accessible for inspection and possible repairs.

4.25 The enclosure shall be designed to practically eliminate the external electromagnetic field and thereby electro-dynamic stresses even under short circuit conditions.

4.26 The elbows, bends, cross and T-sections of interconnections shall include the insulators bearing the conductor when the direction changes take place in order to ensure that live parts remain perfectly centered and the electrical field is not increased at such points.

4.28 The Average Intensity of electromagnetic field shall not be more than 500 micro Tesla. The contractor shall furnish all calculations and documents in support of the above during detailed engineering.
4.29 The Bidder shall furnish the following information regarding the loosely distributed metallic particles within the GIS encapsulation.

a) Calculations of critical field strength for specific particles of defined mass and geometry.

b) The methodology and all the equipment for electrical partial discharge (PD) detection and/or acoustic detection methods, including that mentioned in the specification elsewhere.

4.30 The switchgear shall have provision for connection with ground mat risers. This provision shall consist of grounding pads to be connected to the ground mat riser in the vicinity of the equipment.

4.31 The ladders and walkways shall be provided wherever necessary for access to the equipment. A portable ladder with adjustable height may also be supplied to access to the equipment.

4.32 Wherever required, the heaters shall be provided for the equipment in order to ensure the proper functioning of the switchgear at specified ambient temperatures. The heaters shall be rated for 230V AC supply and shall be complete with thermostat, control switches and fuses, connected as a balanced 3-phase 4-wire load. The possibility of using heaters without thermostats in order to achieve the higher reliability may be examined by the bidder and accordingly included in the offer but it shall be ensured by the bidder that the temperature rise of different enclosures where heating is provided should be within safe limits as per relevant standards. One copy of the relevant extract of standard to which the above arrangement conforms along with cost reduction in offer, if any, shall also be furnished along with the offer. The heaters shall be so arranged and protected as to create no hazard to adjacent equipment from the heat produced.

4.33 The enclosure & support structure shall be designed that a mechanic 1780 mm in height and 90Kg in weight is able to climb on the equipment for maintenance.

4.34 The sealing provided between flanges of two modules / enclosures shall be such that long term tightness is achieved.

4.35 Alarm circuit shall not respond to faults for momentary conditions. The following indications including those required elsewhere in the specifications shall be generally provided in the alarm and indication circuits.

4.35.1 Gas Insulating System:

a) Loss of Gas Density.
b) Loss of Heater power (if required)
c) Any other alarm necessary to indicate deterioration of the gas insulating system.

4.35.2 Operating System:

a) Low operating pressure
b) Loss of Heater power
c) Loss of operating power
d) Loss of control
e) Pole Disordance (pole discrepancy)

4.36 The equipment will be operated under the following ambient conditions:

a) The ambient temperature varies between 3 degree-C and 46 degree-C. However, for design purposes, ambient temperature should be considered as 50 degree-C.
b) The humidity will be about 95% (indoors)
c) The elevation is less than 1000 meters.
d) Seismic zone: IV

4.37 Temperature rise of current carrying parts shall be limited to the values stipulated in IEC-694, under rated current and the climatic conditions at site. The temperature rise for accessible enclosure shall not
exceed 20 degree C above the ambient temperature of 50 degree C. In the case of enclosures, which are accessible but need not be touched during normal operation, the temperature rise limit may be permitted up to 30 degree C above the ambient of 50 degree C.

4.38 In case of any internal arc fault regardless whether it occurs in a bus bar section, a bus bar isolator or the circuit breaker, repair works should be possible without shutting down the substation; at least one bus section and the undisturbed feeder should remain in operation. It should be possible to remove and replace a fully assembled circuit breaker without interfering the operation of the adjacent feeder. All circuit breakers should be interchangeable.

4.39 The GIS equipments shall be arranged in such a manner that in case of maintenance works on any of the equipment, at least one bus section should be available for operation.

4.40 The inter bay width shall be sufficient to allow access to all drive mechanisms and other termination boxes without the need of dismantling other apparatuses.

These conditions shall be taken into account by the supplier in the design of the equipment.

5.0 Bellows or Compensating Units:

Adequate provision shall be made to allow for the thermal expansion of the conductors and of differential thermal expansion between the conductors and the enclosures. The bellows shall be metallic (preferably of stainless steel) of following types or other suitable equivalent arrangement shall be provided wherever necessary.

1) Lateral / Vertical mounting units: These shall be inserted, as required, between sections of bus bars, on transformer and XLPE cable etc. Lateral mounting shall be made possible by a sliding section of enclosure and tubular conductors.

2) Axial compensators: These shall be provided to accommodate changes in length of bus bars due to temperature variations.

3) Parallel compensators: These shall be provided to accommodate large linear expansions and angle tolerances.

4) Tolerance compensators: These shall be provided for taking up manufacturing, site assembly and foundation tolerances.

5) Vibration compensators: These bellow compensators shall be provided for absorbing vibrations caused by the transformers when connected to SF6 switchgear by oil- SF6 bushings.

6.0 Indication and Verification of Switch Positions

Indicators shall be provided on all circuit breakers, isolators and earth switches, which shall clearly show whether the switches are open or closed. The indicators shall be mechanically coupled directly to the main contact operating drive rod or linkages and shall be mounted in a position where they are clearly visible through glass windows.

7.0 Pressure Relief:

Pressure relief devices shall be provided in the gas sections to protect the main gas enclosures from damage or distortion during the occurrence of abnormal pressure increase or shock waves generated by internal electrical fault arcs (preferably in downward direction).

Pressure relief shall be achieved either by means of diaphragms or plugs venting directly into the atmosphere in a controlled direction. If the pressure relief devices vent directly into the atmosphere, suitable guards and deflectors shall be provided. Contractor shall submit to the Employer the de-tailed criteria design regarding location of pressure relief devices/rupture diaphragms.
8.0 Pressure Vessel Requirements

The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel code (ASME/CENELEC code for pressure Vessel.)

Each enclosure has to be tested as a routine test at 1.5 time the design pressure for one minute. The bursting strength of Aluminium castings has to be at least 5 times the design pressure. A bursting pressure test shall be carried out at 5 times the design pressure as a type test on each type of enclosure.

9.0 Grounding

The grounding system shall be designed and provided as per IEEE-80-2000 and CIGRE-44 to protect operating staff against any hazardous touch voltages and electro-magnetic interferences.

As the area involved is small, Supplier has to take special measures for the same.

The GIS supplier shall define clearly what constitutes the main grounding bus of the GIS. The GIS supplier must supply the entire material for grounding bus of GIS viz. conductor, clamps, joints, operating and safety platforms etc. The GIS supplier is also required to supply all the earthing conductors and associated hardware material for the following:

1) Connecting all GIS equipment, enclosures, control cabinets, supporting structure etc. to the ground bus of GIS.
2) Grounding of transformer and other outdoor switchyard equipments/structures etc.

The enclosure of the GIS may be grounded at several points so that there shall be grounded cage around all the live parts. A minimum of two nos. of grounding connections should be provided for each of circuit breaker, disconnect switches, cable terminals, surge arrestors, earth switches and at each end of the bus bars. Subassembly to subassembly bonding shall be provided to provide gap & safe voltage gradients between all intentionally grounded parts of the GIS assembly & between those parts and the main grounding bus of the GIS.

Each marshalling box, local control panel, power and control cable sheaths and other non current carrying metallic structures shall be connected to the grounding system of GIS via connections that are separated from GIS enclosures.

The grounding connector shall be of sufficient mechanical strength to withstand electromagnetic forces as well as capable of carrying the anticipated maximum fault current without overheating. At least two grounding paths shall be provided to connect each point to the main grounding bus. Necessary precautions should be undertaken to prevent excessive currents from being induced into adjacent frames, structures of reinforcing steel and to avoid establishment of current loops via other station equipment.

All flexible bonding leads shall be tinned copper. All connectors, for attaching flexible bonding leads to grounding conductors and grounding conductors to support structures shall be tinned bronze with stainless steel or tinned bronze hardware.

The contractor shall provide suitable measure to mitigate transient enclosure voltage caused by high frequency currents caused by lightning strikes, operation of surge arrestor, phase/earth fault and discharges between contacts during switching operation. The grounding system shall ensure safe touch & step voltages in all the enclosures. The contractor shall provide suitable barrier of non-linear resistor/counter discontinued SF6/ Air termination, SF6/ Transformer termination, SF6/ HV cable bushing etc. to mitigate transient enclosure voltage.

Any provision to be made in the building design to take care of earthing requirement shall also be clearly spelt-out.
10 Circuit Breakers

General

SF6 gas insulated metal enclosed circuit breakers shall comply with the latest revisions of IEC-62271-100 & relevant IEC except to the extent explicitly modified in the specification and shall meet with requirements specified.

Circuit breakers shall be equipped with the operating mechanism. 220kV SF6 Circuit breakers shall be of single pressure (puffer) type. Complete circuit breaker with all necessary items for successful operation shall be supplied. The circuit breakers shall be designed for high speed single and three phase re-closing with an operating sequence and timing as specified.

10.1 Duty Requirements

Circuit breaker shall be C2-M1-E1 class as per IEC 62271-100.

Circuit breaker shall meet the duty requirements for any type of fault or fault location also for line charging and dropping when used on 220kV effectively grounded system and perform make and break operations as per the stipulated duty cycles satisfactorily.

10.2 The circuit breaker shall be capable of:

i) Interrupting the steady and transient magnetizing current corresponding to 220kV /33kV class transformers of 31.5 MVA ratings on 220kV side.

ii) Interrupting line/cable charging current as per IEC without re-strikes and without use of opening resistors.

iii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iv) Breaking 25% the rated fault current at twice the rated voltage under phase opposition condition.

The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.

10.3 Total Break Time

The total break time shall not be exceeded under any of the following duties:

i) Test duties T10,T30,T60,T100 (with TRV as per IEC- 62271-100 )

ii) Short line fault L90, L75 (with TRV as per IEC-62271-100 )

The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage (70-110%), spring actuating mechanism and SF6 gas pressure etc. While furnishing the proof for the total break time of complete circuit breaker, the bidder may specifically bring out the effect of non simultaneity between poles (pole discrepancy) and show how it is covered in the total break time. The values guaranteed shall be supported with the type test reports.

10.4 Constructional Features

The features and constructional details of breakers shall be in accordance with requirements stated hereunder:
10.4.1 Contacts

All making and breaking contacts' shall be sealed and free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacement due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

10.4.2 Any device provided for voltage grading to damp oscillations or, to prevent re-strike prior to the complete interruption of the circuit or to limit over voltage on closing, shall have a life expectancy comparable to that of the breaker as a whole.

10.4.3 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life for the material used. The temperature rise shall not exceed that indicated in IEC-62271-100 under specified ambient conditions.

10.4.4 For 220kV C.B’s, the gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage for eight hours at zero pressure above atmospheric level of SF6 gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lockout pressure continuously (i.e. 2 pu. power frequency voltage across the breaker continuously)

10.4.5 For 220kV C.B’s in the interrupter assembly there shall be an adsorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as to be fully compatible with SF6 gas decomposition products.

10.4.6 Provisions shall be made for attaching an operational analyzer to record travel, speed and making measurement of operating timings etc. after installation at site.

10.4.7 Static Contact Resistance Meter and Dynamic Contact Resistance Meter shall also be provided along with CB operational analyzer.

10.5 Operating Mechanism

10.5.1 General Requirements:

a) Circuit breaker shall be operated by spring charged mechanism. The mechanism shall be housed in a dust-proof cabinet and shall have IP: 42 degree of protection.

b) The operating mechanism shall be strong, rigid, not subject to rebound or to critical adjustments at site and shall be readily accessible for maintenance.

c) The operating mechanism shall be suitable for high speed re-closing and other duties specified. During re-closing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.

d) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.

e) A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

f) Working parts of the mechanism shall be of corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker.
g) The bidder shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

10.5.2 Control

a) The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

b) Each 220kV breaker pole shall be provided with two (2) independent tripping circuits, valves, pressure switches, and coils each connected to a different set of protective relays.

c) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the breaker central control cabinet.

d) The trip coil shall be suitable for trip circuit supervision during both open and close position of breaker.

e) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip and associated circuits shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

f) Density meter contacts and pressure switch contacts shall be suitable for direct use as permissive in closing and tripping circuits of substation automation system. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuit shall be monitored and for remote annunciations and operation lockout in case of dc failures.

g) The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

10.5.3 Spring operated Mechanism

a) Spring operated mechanism shall be complete with motor in accordance with IEC. Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

b) As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.

c) After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

d) Breaker operation shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it required preferably not more than 60 seconds for full charging of the closing spring.

e) Closing action of circuit breaker shall compress the opening spring ready for tripping.

f) When closing springs are discharged after closing a breaker, closing springs shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

g) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partially charged condition.
h) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is in the closed position. The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

10.6 Additional Data to Be Furnished Along with the Offer:

a) Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100 fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

c) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and hydraulic pressure.

d) Quality assurance plan starting from the selection and procurement of material itself till performing the shop acceptance.

10.7 Tests

10.7.1 In accordance with the requirements stipulated in the BOQ and in this specification of the circuit breaker along with its operating mechanism shall conform to the type tests as per IEC-62271-100.

10.7.2 Routine Tests

Routine tests as per IEC: 62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-re-closing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console etc. shall be furnished as mandatory maintenance equipment.

The test for getting signature of the dynamic contact resistance measurement shall also be carried out at factory. The test result shall be treated as reference signature for condition monitoring in future.
10.7.3 Technical Parameters - Circuit Breaker

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Technical particular</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage kV (rms)</td>
<td>245</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency (Hz)</td>
<td>50</td>
</tr>
<tr>
<td>c)</td>
<td>No. of poles</td>
<td>3</td>
</tr>
<tr>
<td>d)</td>
<td>Type of circuit breaker</td>
<td>SF6 insulated</td>
</tr>
<tr>
<td>e)</td>
<td>Rated continuous current (A) at an ambient temperature of 40°C</td>
<td>1600/2500 (2500 for bus coupler breaker)</td>
</tr>
<tr>
<td>f)</td>
<td>Rated short circuit capacity</td>
<td>40 kA with percentage of DC component as per IEC-62271-100 corresponding to minimum opening conditions as specified.</td>
</tr>
<tr>
<td>g)</td>
<td>Symmetrical interrupting capability kA (rms)</td>
<td>40</td>
</tr>
<tr>
<td>h)</td>
<td>Rated short circuit making current kAp</td>
<td>100</td>
</tr>
<tr>
<td>i)</td>
<td>Short time current carrying capability for one second kA (rms)</td>
<td>40</td>
</tr>
<tr>
<td>j)</td>
<td>Rated line charging interrupting current at 90 deg. Leading power factor angle (A rms)</td>
<td>As per IEC</td>
</tr>
<tr>
<td>k)</td>
<td>First pole to clear factor</td>
<td>1.3</td>
</tr>
<tr>
<td>l)</td>
<td>Rated break time as IEC (ms)</td>
<td>60</td>
</tr>
<tr>
<td>m)</td>
<td>Total break time (ms)</td>
<td>65</td>
</tr>
<tr>
<td>n)</td>
<td>Total closing time (ms)</td>
<td>Not more than 200</td>
</tr>
<tr>
<td>o)</td>
<td>Rated operating duty cycle</td>
<td>O-0.3s-CO-3 min-CO</td>
</tr>
<tr>
<td>p)</td>
<td>Re-closing auto re-closing</td>
<td>Single phase/ Three phase</td>
</tr>
<tr>
<td>q)</td>
<td>Rated insulation levels</td>
<td></td>
</tr>
<tr>
<td>r)</td>
<td>Full wave impulse with stand voltage (1.2x50 micro sec.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- between line terminals and ground</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td></td>
<td>- between terminals with circuit breaker open</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td></td>
<td>One minute power frequency withstand voltage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- between line terminals and ground</td>
<td>As per IEC</td>
</tr>
<tr>
<td></td>
<td>- between terminals with circuit breaker</td>
<td>As per IEC</td>
</tr>
</tbody>
</table>
Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 156 kV (Microvolts) 1000

Max. difference in the instants of closing/opening of contacts (ms) between poles As per IEC

Trip coil and closing coil voltage this Section 220V DC with variation as specified in Sec GTR

Auxiliary Contacts Auxiliary switch shall also comply with requirements as given. Independent single pole reversible contacts (from NO to NC & vice versa) Each circuit breaker pole shall be provided with an auxiliary switch with 20% of spare – NO and 20% spare NC contact for use in future.

Rating of Auxiliary contacts 10A at 220V DC

Breaking capacity of Aux. Contacts. 2A DC with the circuit time constant of not less than 20 ms.

System neutral earthing Effectively earthed.

11.0 Disconnectors (Isolators)

11.1 General

Disconnectors shall be of the single-pole, group operated type, installed in the switchgear to provide electrical isolation of the circuit breakers, the transformers, single bus and transmission lines/cables. The disconnectors shall conform to IEC- 62271-102 and shall have the following ratings as specified.

Technical Parameter

<table>
<thead>
<tr>
<th>S.No</th>
<th>Particulars</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage (rms) Un</td>
<td>245 kV</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 HZ</td>
</tr>
<tr>
<td>c)</td>
<td>System earthing</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Type</td>
<td>SF6 insulated</td>
</tr>
<tr>
<td>e)</td>
<td>Rated continuous current (A) at 40°C ambient temp.</td>
<td>1600/2500(for line, Transformer /bus coupler)</td>
</tr>
<tr>
<td>f)</td>
<td>Rated short time withstand current of isolator and earth switch</td>
<td>40 kA for 1 Sec</td>
</tr>
<tr>
<td>g)</td>
<td>Rated dynamic short circuit withstand current of isolator and earth switch</td>
<td>100 kAp</td>
</tr>
<tr>
<td>h)</td>
<td>Rated insulation level: One minute power freq. Withstand voltage:</td>
<td>As per IEC</td>
</tr>
<tr>
<td>i)</td>
<td>Rated insulation levels; 1.2/50 micro sec. Lighting impulse withstand voltage (+ve or –ve polarity)</td>
<td>As per IEC</td>
</tr>
<tr>
<td>j)</td>
<td>Rated mechanical terminal load</td>
<td>±1200 kVp</td>
</tr>
<tr>
<td>k)</td>
<td>No. of spare auxiliary contacts on each</td>
<td>4NO and 4 NC</td>
</tr>
</tbody>
</table>
11.2 Construction & Design

11.2.1 The three pole group operated disconnectors shall be operated by electric motor suitable for use on 220 V DC system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over current and short circuit.

11.2.2 Disconnectors shall be designed as per relevant IEC. These shall be suitable to make and break the charging currents during their opening and closing. They shall also be able to make and break loop current which appears during transfer between bus bars. The contact shielding shall also be designed to prevent re-strikes and high local stresses caused by transient recovery voltages when these currents are interrupted.

11.2.3 The disconnecting switches shall be arranged in such a way that all the three phases operate simultaneously. All the parts of the operating mechanism shall be able to withstand starting torque of the motor mechanism without damage until the motor overload protection operates.

11.2.4 It shall be possible to operate the disconnecting switches manually by cranks or hand wheels. The contacts shall be both mechanically and electrically disconnected during the manual operation.

11.2.5 The operating mechanisms shall be complete with all necessary linkages, clamps, couplings, operating rods, support brackets and grounding devices. All the bearings shall be permanently lubricated or shall be of such a type that no lubrication or maintenance is required.

11.2.6 The opening and closing of the disconnectors shall be achieved by either local or remote control. The local operation shall be by means of a two-position control switch located in the bay module control cabinet.

11.2.7 Remote control of the disconnectors from the control room shall be made by means of remote/local transfer switch.

11.2.8 The disconnector operations shall be inter-locked electrically with the associated circuit breakers in such a way that the disconnector control is inoperative if the circuit breaker is closed.

11.2.9 Each disconnector shall be supplied with auxiliary switch having six normally open and six normally closed contacts for future use over and above those required for switchgear interlocking and automation purposes. The auxiliary switch contacts are to be continuously adjustable such that, when required, they can be adjusted to make contact before the main switch contacts.

11.2.10 The signaling of the closed position of the disconnector shall not take place unless it is certain that the movable contacts will reach a position in which the rated normal current, peak withstand current and short-time withstand current can be carried safely.

11.2.11 The signaling of the open position of the disconnector shall not take place unless the movable contacts have reached such a position that the clearance between the contacts is at least 80 percent of the rated isolating distance.

11.2.12 All auxiliary switches and auxiliary circuits shall be capable of carrying a current of at least 10 A DC continuously.

11.2.13 The auxiliary switches shall be capable of breaking at least 2 A in a 220 V DC circuit with a time constant of not less than 20 milliseconds.
11.2.14 The disconnectors and safety grounding switches shall have a mechanical key (pad locking key) and electrical inter-locks to prevent closing of the grounding switches when isolator switches are in the closed position and to prevent closing of the disconnectors when the grounding switch is in the closed position.

11.2.15 The local control of the Isolator and high-speed grounding switches from the bay module control panel should be achieved from the individual control switches with the remote/local transfer switch set to local.

11.2.16 All electrical sequence interlocks will apply in both remote and local control modes.

11.2.17 Each disconnector shall have a clearly identifiable local, positively driven mechanical position indicator, together with position indicator on the bay module control cabinet and provisions for taking the signals to the control room. The details of the inscriptions and colouring for the indicator are given as under:

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open position</td>
<td>Open</td>
</tr>
<tr>
<td>Closed position</td>
<td>Closed</td>
</tr>
</tbody>
</table>

11.2.18 All the disconnecting switches shall have arrangement allowing easy visual inspection of the travel of the switch contacts in both open and close positions, from the outside of the enclosure.

11.2.19 The disconnecting switches shall be provided with rating plates and shall be accessible for inspection.

11.2.20 The disconnecting switches shall be capable of being padlocked in both the open and closed positions with the operating motor automatically disengaged. The padlocking device shall be suitable for a standard size lock with a 10 mm shank. The padlock must be visible and directly lock the final output shaft of the operating mechanism. Integrally mounted lock when provided shall be equipped with a unique key for such three phase group. Master key is not permitted.

12.0 Safety Grounding Switches

12.1 Three-pole, group operated, safety grounding switches shall be operated by electric motor for use on 220 V DC ungrounded system and shall be equipped with a manual operating mechanism for emergency use. The motor shall be protected against over-current and short circuit.

12.2 Each safety grounding switch shall be electrically interlocked with its associated disconnector and circuit breaker such that it can only be closed if both the current breaker and disconnector are in open position. Safety grounding switch shall also be mechanically key interlocked with its associated disconnector.

12.3 Each safety grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal to Control room.

12.4 The details of the inscription and colouring for the indicator are given as under:

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open position</td>
<td>Open</td>
</tr>
<tr>
<td>Closed position</td>
<td>Closed</td>
</tr>
</tbody>
</table>
12.5 Interlocks shall be provided so that manual operation of the switches or insertion of the manual operating device will disable the electrical control circuits.

12.6 Each ground switch shall be fitted with auxiliary switches having six normally open and six normally closed contacts for use by others over and above those required for local interlocking and position indication purposes.

12.7 Provision shall be made for padlocking the ground switches in either the open or closed position.

12.8 All portions of the grounding switch and operating mechanism required for grounding shall be connected together utilizing flexible copper conductors having a minimum cross-sectional area of 50 sq. mm.

12.9 The main grounding connections on each grounding switch shall be rated to carry the full short circuit rating of the switch for 1 sec. and shall be equipped with a silver-plated terminal connector suitable for steel strap of adequate rating for connection to the grounding grid.

12.10 The safety grounding switches shall conform to the requirements of IEC-62271-102

12.11 Mechanical position indication shall be provided locally at each switch and remotely at each bay module control cabinet/substation automation system.

12.12 The rated Induced Current and Voltage for earth switches for both electrostatic and electromagnetic coupling shall be as per IEC 62271-102.

13.0 High Speed Make Proof Grounding Switches

13.1 Grounding switches located at the beginning of the feeder bay modules shall be of the high speed make proof type and will be used to discharge the respective charging currents, in addition to their safety grounding function. These grounding switches shall be capable of interrupting the inductive currents and to withstand the associated TRV.

13.2 Single phase switches shall be provided with operating mechanism suitable for operation from a 220V DC.

13.3 The switches shall be fitted with a stored energy closing system to provide fault making capacity.

13.4 The short circuit making current rating of each ground switch shall be at least equal to its peak withstand current rating. The switches shall have inductive/capacitive current switching capacity as per IEC-62271-102.

13.5 Each high speed make proof grounding switch shall have clearly identifiable local positive driven mechanical indicator together with position indicator on the bay module control cabinet and provision for taking the signal Control Room.

13.6 The details of the inscription and colouring for the indicator shall be as under:-

<table>
<thead>
<tr>
<th>SIGN</th>
<th>COLOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN POSITION</td>
<td>Open</td>
</tr>
<tr>
<td>CLOSED POSITION</td>
<td>Closed</td>
</tr>
</tbody>
</table>

13.7 High speed ground switch operation should be possible locally from the bay module control cabinet, or remotely from the control room in conjunction with opening of the associated disconnector.
13.8 These high speed grounding switches shall be electrically interlocked with their associated circuit breakers and disconnectors so that the grounding switches can not be closed if the circuit breakers and disconnectors are closed.

13.9 Interlocks shall be provided so that the insertion of the manual operating devices will disable the electrical control circuits.

13.10 Each high speed ground switch shall be fitted with auxiliary switches having six NO & six NC auxiliary contacts for use by others, over and above these required for local interlocking and position indication. All contacts shall be wired to terminal blocks in the local bay control cabinet. Provision shall be made for padlocking the ground switches in their open or closed position.

13.11 All portion of the grounding switches and operating mechanism required for connection to ground shall be connected together utilizing copper conductor having minimum cross-sectional area of 50 sq. mm.

13.12 The main grounding connection on each grounding switch shall be rated to carry the short time withstand current rating of the switch for 1 sec. and shall be equipped with a silver plated terminal connector suitable for steel strap of adequate design for connection to the grounding grid.

13.13 The high speed make proof grounding switches shall confirm to the requirements of IEC-62271-102.

13.14 The rated Induced Current and Voltage for earth switches for both electrostatic and electromagnetic coupling shall be as per IEC 62271-102.

14.0 Instrument Transformers

14.1 Current Transformers

A) General:

i) The current transformers and accessories shall conform to IEC: 60044-1 and other relevant standards except to the extent explicitly modified in the specification.

ii) The particulars of the various cores may change within reasonable limits as per the requirements of protection relay supplier. The manufacturer is required to have these values confirmed from the purchaser before proceeding with design of the cores. The other characteristics of CTs shall be as given in TECHNICAL PARAMETER of Current Transformer.

B) Ratios and Characteristics

The number, rating, ratios, accuracy class, etc. for the individual current transformers secondary cores shall be in accordance with Table-IA of SLD.

Where multi-ratio current transformers are required the various ratios shall be obtained by changing the effective number of turns on the secondary winding.

C) Rating and Diagram Plates

Rating and diagram plates shall be as specified in the IEC specification incorporating the year of manufacture. The rated extended current rating voltage and rated thermal current shall also be marked on the name plate.

The diagram plates shall show the terminal markings and the relative physical arrangement of the current transformer cores with respect to the primary terminals (P1 & P2).

The position of each primary terminal in the current transformer SF6 gas section shall be clearly marked by two plates fixed to the enclosure at each end of the current transformer.
D) Constructional Details:

a) The current transformers incorporated into the GIS will be used for protective relaying and metering and shall be of metal enclosed type. The secondary windings shall be air insulated/Gas insulated with terminals brought out for secondary connection. All the current transformers shall have effective electromagnetic shields to protect against high frequency transients.

b) Each current transformer shall be equipped with a marshalling box with terminals for the secondary circuits, which are connected to the local control cubicle. The star/ delta configuration and the inter connection to the line protection panels will be done at the CT terminal block located in the local control cubicle.

c) Current transformers guaranteed burdens and accuracy class are to be intended as simultaneous for all cores.

d) The rated extended primary current shall be 150% at all ratios.

e) The instrument security factor at all ratios shall be less than five (5) for metering core. ISF shall be verified without use of any auxiliary reactor.

f) The wiring diagram, for the interconnections of the three single phase CTs shall be provided inside the marshalling box.

g) The current transformers shall be suitable for high speed auto-reclosing.

h) Provisions shall be made for primary injection testing either within CT or outside.

i) Electromagnetic shields to be provided against high frequency transients typically 1-30 MHz.

j) The bidder will take care for the compatibility of the CT vis-à-vis burden of relay and connecting leads, however for calculation purpose fault current may be taken as 40kA for 220kV.

14.2 Voltage Transformers

A) General

The voltage transformers shall conform to IEC- 60044-2 and other relevant standards except to the extent explicitly modified in the specification.

Voltage transformers shall be of the electromagnetic type with SF6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box.

B) Ratios and Characteristics

The rating, ratio, accuracy class, connection etc. for the voltage transformers shall be in accordance with Table II-A.

C) Rating and diagram plates

Rating and diagram plate shall be provided complying with the requirements of the IEC specification incorporating the year of manufacture and including turns ratio, voltage ratio, burden, connection diagram etc.

D) Secondary Terminals, Earthing and Fuses

The beginning and end of each secondary winding shall be wired to suitable terminals accommodated in a terminal box mounted directly on the voltage transformer section of the SF6 switchgear.
All terminals shall be stamped or otherwise marked to correspond with the marking on the diagram plate. Provision shall be made for earthing of the secondary windings inside the terminal box.

E) The transformer shall be able to sustain full line to line voltage without saturation of transformer.

The accuracy class will be at maximum tap.

F) Constructional Details of Voltage Transformers:

a) The voltage transformers shall be located in a separate bay module on the bus and will be connected phase to ground and shall be used for protection, metering and synchronization.

b) The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF6 compartment, separated from other parts of installation. The voltage transformers shall be effectively shielded against high frequency electromagnetic transients. The voltage transformers shall have three secondary windings.

c) Voltage transformer’s secondary shall be protected by HRC cartridge type fuses for all the windings. In addition fuses shall be provided for the protection and metering windings for fuse monitoring scheme. The secondary terminals of the VT’s shall be terminated to the stud type non-disconnecting terminal blocks in the secondary boxes via the fuse.

d) The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens.

e) The accuracy of 0.2 on secondary III should be maintained throughout the entire burden range up to 100VA on all the three windings without any adjustments during operation.

f) The diagram for the interconnection of the VTs shall be provided inside the marshalling box.

14.3 Tests

Current and voltage transformers shall conform to type tests and shall be subjected to routine test in accordance with IEC.

14.4 Technical Parameters:

14.4.1 Current Transformers

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated voltage Un</td>
<td>245kV (rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>c)</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>Rated short time thermal current</td>
<td>40 kA for 1 second</td>
</tr>
<tr>
<td>e)</td>
<td>Rated dynamic current</td>
<td>100 kAp</td>
</tr>
<tr>
<td>f)</td>
<td>Rated insulation levels</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>1.2/50 micro second impulse voltage</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td>ii)</td>
<td>1 Minute power frequency withstand voltage</td>
<td>460 kV (rms)</td>
</tr>
<tr>
<td>g)</td>
<td>One minute power frequency withstand voltage</td>
<td>5kV (rms)</td>
</tr>
<tr>
<td>h)</td>
<td>Maximum temperature rise over an ambient temperature of 400C</td>
<td>As per IEC 60044-1</td>
</tr>
<tr>
<td>i)</td>
<td>Radio interference voltage at 1.1</td>
<td>1000 microvolts</td>
</tr>
</tbody>
</table>
### 14.4.2 Voltage Transformers

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Particulars</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated system voltage (Un)</td>
<td>245 kV (rms)</td>
</tr>
<tr>
<td>b)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>c)</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>d)</td>
<td>System fault level</td>
<td>40 kA for 1 second</td>
</tr>
<tr>
<td>e)</td>
<td>Rated insulation levels</td>
<td></td>
</tr>
<tr>
<td>i)</td>
<td>1.2/50 micro second impulse voltage.</td>
<td>±1050 kVp</td>
</tr>
<tr>
<td>ii)</td>
<td>1 Minute power frequency withstand voltage.</td>
<td>460 kV (rms)</td>
</tr>
<tr>
<td>f)</td>
<td>One minute power frequency withstand voltage for secondary</td>
<td>3 kV (rms)</td>
</tr>
<tr>
<td>g)</td>
<td>Radio interference voltage at 1.1 Un/\sqrt{3} and frequency range 0.5 to 2 MHz</td>
<td>1000 microvolts</td>
</tr>
<tr>
<td></td>
<td>Rated total thermal burden</td>
<td>400VA</td>
</tr>
<tr>
<td></td>
<td>Partial discharge level</td>
<td>10 Pico coulomb</td>
</tr>
</tbody>
</table>

### 15.0 Outdoor Bushings

**A) General**

Outdoor bushings, for the connection of conventional external conductors/Aluminum tubes to the SF6 metal enclosed switchgear, shall be provided where specified and shall conform to the requirements given in the specification.

The dimensional and clearance requirements for the metal enclosure will be the responsibility of the manufacturer and their dimensions must be coordinated with the switchgear.

Bushings shall generally be in accordance with the requirements of IEC publication 137 as applicable.

**B) Insulation levels and creepage distances**

All bushings shall have an impulse and power frequency withstand level that is greater than or equal to the levels specified for GIS.

The creepage distance over the external surface of outdoor bushings shall not be less than 25 mm/kV.

**C) Bushing types and fitting**

Condenser type bushings will be preferred but alternative types can also be considered.

Liquid filled bushings shall be provided with liquid level gauges clearly visible from ground level, preferably of the direct reading prismatic type or the magnetic type. Other types of liquid level gauges will only be accepted if specifically approved.

**D) Mechanical forces on bushing terminals**
Outdoor bushings must be capable of withstanding cantilever forces due to weight of conductor/Aluminum tube, wind force and short circuit forces etc. Design calculations in support of the cantilever strength chosen shall be submitted for Employers review and approval.

16.0 Surge Arrestors

The surge arrestors shall confirm in general to latest IEC –60099-4.

16.1 Insulation Co-ordination and Selection of Surge Arrestor

The contractor shall be fully responsible for complete insulation co-ordination of transformer yard including GIS. Contractor shall carry out detailed studies and design calculations to evolve the required parameters such that adequate protective margin is available between peak impulse, surge and power frequency discharge voltages and BIL of the protected requirement. If distance between Surge Arrestor and transformer bushing terminal inclusive of head length is more than 60 m or 170 ft then one surge arrestor shall be with GIS System and another shall be with transformer.

The contractor shall perform all necessary studies. The report shall detail the limits of all equipment parameters which could affect the insulation coordination the report shall also detail the characteristics of the surge arrestor and shall demonstrate that the selected insulators protective and withstand levels, discharge currents, discharging and coordinating currents, and arrestor ratings comply with the requirement of this specification.

The contractor shall also consider in the studies the open circuit breaker condition, fast transients generated by slow operation of disconnecting switches. The study report and design calculations shall be submitted for approval of the purchaser.

16.2 Duty Requirements

a) The surge arrester shall be SF6 filled, heavy duty station class and gapless (Metal oxide) type without any series or shunt gaps.

b) The surge arresters shall be capable of discharging over-voltages occurring during switching of unloaded transformers and long lines.

c) 245 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV system on two successive operations.

d) The reference current of the arresters shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

e) The surge arresters are being provided to protect the followings whose insulation levels are indicated in the table given below:-

<table>
<thead>
<tr>
<th>Equipment to be protected</th>
<th>Lightning impulse ( (kVp) ) For 245 kV system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Transformer</td>
<td>± 950</td>
</tr>
<tr>
<td>Instrument Transformer</td>
<td>± 1050</td>
</tr>
<tr>
<td>Reactor</td>
<td>-</td>
</tr>
<tr>
<td>CB/Isolator</td>
<td>± 1050</td>
</tr>
<tr>
<td>Phase to ground</td>
<td>± 1200</td>
</tr>
<tr>
<td>Across open contacts</td>
<td>± 1200</td>
</tr>
</tbody>
</table>
16.3 Constructional Features

The nonlinear blocks shall be of sintered metal oxide material. These shall be provided in such a way as to obtain robust construction, with excellent mechanical and electrical properties even after repeated operations.

The arrestor enclosure shall be vertically or horizontally mounted to suit the layout of the switchgear as suggested by the manufacturer and shall be fitted with a discharge counter located in an easily accessible position.

The main grounding connection from the surge arrestor to the earth shall be provided by the bidder. The size of the connecting conductor shall be such that all the energy is dissipated to the ground without getting overheated.

16.4 Fittings and Accessories for outdoor SA

a) Self contained discharge counters, suitably enclosed and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit. Suitable leakage current meters should also be supplied within the same enclosure. The reading of milli ammeter and counters shall be visible through an inspection glass panel.

b) Microprocessor based instrument for monitoring resistive current or watt loss of the arrester shall also be provided.

16.5 Tests

In accordance with the requirements stipulated the surge arrestors shall conform to type tests and shall be subjected to routine and acceptance tests in accordance with IEC document.

Each metal oxide block shall be tested for the guaranteed specific energy capability in addition to the routine/acceptance test as per IEC-60099.

Test on Surge Monitors:

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulse withstands tests to verify efficacy of the same. Additional routine/functional tests with one 100A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the surge monitor.

16.6 Parameters

Following are the parameters generally adopted by Employer for their installations. These parameters are indicative and not binding. The actual parameters required for the installation shall be evolved by contractor.

Surge Arrestor

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Rated system voltage</td>
<td>245 kV</td>
</tr>
<tr>
<td>b)</td>
<td>System neutral earthing</td>
<td>Effectively earthed</td>
</tr>
<tr>
<td>c)</td>
<td>Rated arrestor voltage</td>
<td>216 kV</td>
</tr>
<tr>
<td>e)</td>
<td>Nominal discharge current</td>
<td>10 kA of 8/20 micro second wave</td>
</tr>
<tr>
<td>f)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>g)</td>
<td>Minimum discharge capability voltage corresponding to minimum discharge characteristics</td>
<td>5 KJ/kV (referred to rated arrestor)</td>
</tr>
<tr>
<td>h)</td>
<td>Continuous operating voltage at</td>
<td>168 kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>Min. switching surge residual voltage (1 kA)</td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>Max. switching surge residual voltage (1 kA)</td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Max. residual voltage at 5 kA</td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>ii) 10 kA nominal discharge current</td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>iii) 20 kA nominal discharge current</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Long duration discharge class</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>High current short duration test value (4/10 micro second wave)</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Current for pressure relief test</td>
<td></td>
</tr>
<tr>
<td>q</td>
<td>Prospective symmetrical fault current</td>
<td></td>
</tr>
<tr>
<td>r</td>
<td>Pressure relief class:</td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>RIV at 1.1 Un/√3 kV rms(micro volts)</td>
<td></td>
</tr>
<tr>
<td>t</td>
<td>Partial discharge at 1.05 COV</td>
<td></td>
</tr>
<tr>
<td>u</td>
<td>Reference ambient temp.</td>
<td></td>
</tr>
<tr>
<td>v</td>
<td>Steep current impulse voltage</td>
<td></td>
</tr>
</tbody>
</table>

17.0 220KV GIS Building

a) Buildings shall house 220 KV Gas Insulated Switchgear (GIS) separately and other associated equipments inside in each of the GIS building.
b) The bidder shall submit the design & construction proposal of the building along with necessary information, data, and drawings in the techno-commercial bid according to the complete requirements.
c) The plot plan of floor for 220 KV GIS building is enclosed. The dimension given is for reference only and may vary according to requirement of the equipment to be installed inside. The bidder shall finalize the dimensions according to the equipment offered by them providing enough space & access for erection, operation and maintenance.

18.0 Seismic Design Criteria:
The equipment shall be designed for operation in seismic zone for earthquake resistance. The seismic loads are due to the horizontal and vertical acceleration which may be assumed to act non concurrently. Seismic level Zone- IV, as per new IS- 1893, Year-2002 has to be considered for the design of equipment. The seismic loads shall be equal to static loads corresponding to the weight of the parts multiplied by the acceleration. The equipments along with its parts shall be strong enough and sufficiently well connected to resist total operating stresses resulting from the forces in normal operation but in case of abnormal condition shall also resist with forces superimposed due to earthquakes. The copies of type test reports for similar rated equipment, if tested earlier, should be furnished along with the tender. If the equipment has not been type tested earlier, design calculations of simulated parameters should be furnished along with the offer.

To prevent the movement of GIS sub assemblies i.e. various bay modules during the earthquake, suitable devices shall be provided for fixing the sub assemblies to the foundation. The contractor shall supply necessary bolts for embedding in the concrete foundation. The fixing of GIS sub assemblies to the foundation shall be designed to with-stand the seismic events. It will also be ensured that the special devices as well as
bolts shall not be over stressed. The details of the devices used and the calculations for establishing the adequacy shall be furnished by the supplier and shall be subject to the purchase’s approval.

19.0 Partial Discharge Monitoring System & Dew Point Meter

Static Contact Resistance Meter and Dynamic Contact Resistance Meter, CB operational Analyzer, SF6 Gas Detector Meter, Portable P.D meter & Dew point meter shall be offered. The specifications are enclosed at Section- Special Equipment.

20.0 Quality of SF6 Gas

a) The SF6 gas insulated metal-clad switchgear shall be designed for use with SF6 gas complying with the recommendations of IEC 376, 376A & 376B, at the time of the first charging with gas. All SF6 gas supplied as part of the contract shall comply with the requirements of IEC as above as a minimum & should be suitable in all respects for use in the switchgear under all operating conditions.

b) The high pressure cylinders in which SF6 gas is supplied & stored at site shall comply with the requirements of following standards & regulations:

IS: 4379 Identification of the contents of industrial gas cylinders.

IS: 7311 Seamless high carbon steel cylinders for permanent & high pressure liquefiable gases. The cylinders shall also meet Indian Boilers Regulations. (Mandatory)

c) Test

SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water contents as per IEC:376, 376A & 376B and test certificates shall be furnished to the Employer indicating all test results as per IEC standards for each lot of SF6 gas. Further site tests for moisture, air content, flash point and dielectric strength to be done during commissioning of GIS. Gas bottles should be tested for leakage during receipt at site.

d) The bidder shall indicate diagnostic test methods for checking the quality of gas in the various sections during service. The method proposed shall, as a minimum check the moisture content & the percentage of purity of the gas on annual basis.

e) The bidder shall also indicate clearly the precise procedure to be adopted by maintenance personnel for handling equipment that are exposed to the products of arcing in SF6 Gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, method of disposal of cleaning utensils and other relevant matters.

f) The bidder shall also indicate the details and type of filters used in various gas sections, and should also submit the operating experience with such filters.

21.0 SF6 Gas Monitoring Devices And Alarm Circuits

21.1 Dial type temperature compensated gas density or density monitoring devices with associated pressure gauge will be provided. The devices shall provide continuous & automatic monitoring of the state of the gas & a separate device shall be provided for each gas compartment so that each compartment can be monitored simultaneously as follows:-

1) Compartments except circuit breaker

a) Gas Refill level
This will be used to annunciate the need for the gas refilling. The contractor shall provide a contact for remote indication.

b) 'Zone Trip' level

This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

2) Circuit Breaker (for 220kV level)

a) 'Gas Refill' level

This will be used to annunciate the need for gas refilling. The contractor shall provide a contact for remote indication.

b) 'Breaker Block' level

This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate & the trip-ping & closing circuit shall be blocked.

c) 'Zone Trip' level

This is the minimum level at which the manufacturer will guarantee the insulation rating of the assembly. Contacts shall be in accordance with requirement.

The bidder should furnish temperature v/s pressure curves for each setting of density monitor along with details of the monitoring device.

It shall be possible to test all gas monitoring relays/devices without de-energizing the primary equipment & without reducing pressure in the main section. Plugs & sockets shall be used for test purposes. It shall also damp the pressure pulsation while filling the gas in service, so that flickering of the pressure switch contacts does not take place.

21.2 a) Gas Leakage

The maximum gas leakage shall not exceed 0.5% (half percent) per year for the whole equipment and for any individual gas compartment separately.

b) Gas Supply

The contractor shall include the supply of all SF6 gas necessary for filing & putting into operation the complete switchgear installation being supplied. In addition 20% of total gas requirement shall be supplied in separate cylinders as spare requirement, over & above the requirement of gas for successful commissioning. Pl. refer list of mandatory spares in this connection.

22.0 Gas Filling And Evacuating Plant

All the plant necessary for filling and evacuating the SF6 gas in the switchgear shall be supplied with the contract to enable any maintenance work to be carried out. This shall include all the necessary gas cylinders for temporarily storing the evacuated SF6 gas. The capacity of the temporary storage facilities shall at least be sufficient for storing the maximum quantity of gas that could be removed when carrying out maintenance or repair work on the switchgear and associate equipment of at least one complete bay.

Where any item of the filling and evacuating plant is of such a weight that it cannot easily be carried by maintenance personnel, it shall be provided with lifting hooks for lifting and moving with the overhead cranes.
The capacity of the plant should be such that it is capable of excavation/filling of maximum quantity of gas contained in a compartment could be removed/filled within 30 minutes while carrying out maintenance/repair work.

The evacuation equipment shall be provided with all the necessary pipes, couplings, flexible tubes and valves for coupling up to the switchgear for filling or evacuating all the gases.

The gas compartments shall preferably be fitted with permanent non-return valves through which the gas is pumped into or evacuated from the compartments.

Details of the filling and evacuating plant that will be supplied, as well as the description of the filling and evacuating procedures shall be provided along with the bid.

### 23.0 SF6 GIS to XLPE Cable Termination

The 220kV underground cables are to be connected to 220kV GIS by the interfacing of XLPE cable sealing end to GIS Cable termination enclosure for making connection 3x300 sq. XLPE cable. This interface section shall be designed in a manner which will allow ease of operation and maintenance.

The SF6 GIS to XLPE cable termination shall conform to IEC-859 (latest edition). The provision shall be made for a removable link. The gap created when the link is removed should have sufficient electric strength to withstand the switchgear high voltage site tests. The bidder may suggest alternative arrangements to meet these requirements. The corona rings/stress shields for the control of electrical field in the vicinity of the isolation gap shall be provided by the GIS manufacturer.

All supporting structures for the connections between the XLPE cable sealing ends and the GIS shall be supplied by the supplier. The supplier may specify alternative connecting & supporting arrangements for approval of the purchaser.

The opening for access shall be provided in each phase terminal enclosures as necessary to permit removal of connectors to isolate the XLPE cables to allow carrying out the insulation tests. The typical arrangement drawing of interconnecting cables from GIS bay module to XLPE cable termination end shall be submitted along with offer.

### 24.0 Electric Overhead Crane (If applicable):

EOT Crane of suitable capacity shall be provided for erection & maintenance of of largest GIS component/assembly. The crane shall consist of all special requirements for erection & maintenance of GIS equipments.

The crane shall be possible to be operated through the cable & through the pendant control, which shall be easily accessible from the floor of GIS building.

### 25.0 Transformer Termination

The transformer Termination on 33 KV side shall be through 1x1200 sq.mm XLPE cable and on 220kV side through 101.6 O/D Aluminum Tubular conductor.

### 26.0 Painting Of Enclosure

All enclosures shall be painted externally as per manufacturer’s painting procedure. The painting procedures as followed shall be enclosed with the bid.

### 27.0 Heaters
Wherever required, heaters shall be provided to prevent moisture condensation. Heaters are not allowed inside the main circuit.

28.0 Identification & Rating Plate

i) Each bay shall have a nameplate showing

a) A listing of the basic equipment from air entrance bushing to air entrance bushing (such as a breaker, disconnectors grounding switches, current transformers, voltage transformers, and bushings).

b) A schematic diagram indicating their relative locations.

c) POWERGRID Contract Number.

ii) Each module will have its own Identification & rating plate. The rating plate marking for each individual equipment like circuit breaker, disconnectors grounding switches, current transformer, voltage transformers, surge arrester etc shall be as per their relevant IEC.

TRANSPORT OF EQUIPMENT TO SITE.

The contractor shall be responsible for the loading, transport, handling and offloading of all equipment and materials from the place of manufacture or supply to site. The contractor shall be responsible to select and verify the route, mode of transportation and make all necessary arrangement with the appropriate authorities as well as determining any transport restrictions and regulations imposed by the government and other local authorities. All transport packages containing critical units viz Circuit breakers, disconnectors, earthswitches, surge arrestors and bus sections exceeding 3 metres length shall be provided with sufficient number of electronic impact recorders (on returnable basis) during transportation to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory and must continue till the units reach site. The data of electronic impact recorders shall be downloaded at site and a soft copy of it shall be handed over to Engineer – in –charge. Further, within three weeks the contractor shall communicate the interpretation of the data.

PACKING, STORAGE AND UNPACKING.

All the equipment shall be carefully packed for transport by sea, rail and road in such a manner that it is protected against the climatic conditions and the variations in such conditions that will be encountered enroute from the manufacturer’s works to the site.

The SF6 metalclad equipment shall be shipped in the largest factory assembled units that the transport and loading limitations and handling facilities on site will allow to reduce the erection and installation work on site to a minimum.

Where possible all items of equipment or factory assembled units shall be boxed in substantial crates or containers to facilitate handling in a safe and secure manner. Should the units be considered too large for packing in crates, they shall be suitably lagged and protected to prevent damage to any part, particularly small projections, during transport and handling. Special lugs or protective supports shall be provided for lifting to prevent slings and other lifting equipment from causing damage. Each crate, container or shipping unit shall be marked clearly on the outside to show where the weight is bearing and the correct position for the slings.

Each individual piece to be shipped, whether crate, container or large unit, shall be marked with a notation of the part or parts contained therein.

Special precautions shall be taken to protect any parts containing electrical insulation against the ingress of moisture. This applies particularly to the metalclad equipment of which each gas
section shall be sealed and pressurized prior to shipping. Either dry nitrogen/air or dry SF6 gas shall be used and the pressure shall be such as to ensure that, allowing for reasonable leakage, it will always be greater than the atmospheric pressure for all variations in ambient temperature and the atmospheric pressure encountered during shipment to site and calculating the pressure to which the sections shall be filled to ensure positive pressure at all times during shipment. The type of gas, the maximum pressure to which sections will be filled prior to shipment and the minimum allowable pressure during shipment shall be advised prior to dispatch.

All banking plates, caps, seals, etc., necessary for sealing the gas sections during shipment to site shall be provided as part of the contract and shall remain the property of POWERGRID. If considered necessary, blanking plates or other sealing devices shall be provided with facilities for measuring the gas pressure and recharging at any time during the transport period. Any seals, gaskets, ‘O’ rings, etc. that may be used as part of the arrangement for sealing off gas sections for shipment of site, shall not be used in the final installation of the equipment at site. Identification serial numbers shall be stamped into the blanking plates, etc., and on the switchgear equipment to which they are fitted so that they can easily be identified and refitted should it ever be necessary to ship sections of the switchgear back to the manufacturer’s works for repair.

Valves and other gas couplings associated with the switchgear gas systems shall be adequately protected against damage from any bumps or physical blows. They shall also be capped to prevent ingress of dirt or moisture or damage to any coupling, pipes, threads or special fittings. Any explosion vents and other pressure relief devices, shall be suitably sealed and protected to prevent accidental exposure of the sealed sections during shipment to site.

For bus ducts involving male and female joints of the current carrying conductor, the same shall be transported in disassembled condition to avoid any damage during transit. All bright parts liable to rust shall receive a coat of anti rusting composition and shall be suitably protected.

The contractor will be able to use the available storage areas at site.

The contractor shall ensure that during the period between arrival at site and erection, all materials and parts of the contract works are suitably stored in such approved manner as to prevent damage by weather, corrosion, insects, vermin or fungoral growth. The scope of providing the necessary protection, storing off the ground, as required etc. is included in the works to be performed by the contractor.

The equipment shall only be unpacked or removed from the containers immediately prior to being installed. They shall not be left lying unnecessarily in open crates or containers. Special precautions shall be taken when gas sections which have been sealed and pressurized for shipping are opened up to reduce the ingress of dirt and atmospheric moisture to a minimum. Whenever possible this shall only be done immediately prior to installation and if any section is to be left outside for any length of time after being opened, it shall be resealed and pressurized with either dry nitrogen/air or SF6 gas until required.
The meter shall be capable of measuring the due point of SF6 Gas of the Circuit Breaker/ GIS equipment. It should be portable and adequately protected for outdoor use. The meter shall be provided with due point hygrometer with digital indication to display the due point temperature in degree C., degree F or PPM. It should be capable of measuring the corresponding pressure at which due point is being measured.

The measurement and use of the instrument must be simple, direct without the use of any other material/ chemical like dry ice/ acetone etc. It should be battery operated with rechargeable batteries. It should be suitable for operation on 220 Volts AC mains supply.

Technical specification:

1. Measuring range : Upto -50 degree C Dew Point.
2. Accuracy:  \( \pm 2 \) degree c.
3. Display: 4 digit LCD, 0.5 inch. High.

TECHNICAL SPECIFICATION FOR PORTABLE PD MONITORING SYSTEM FOR GAS INSULATED SWITCHGEAR
1.0 GENERAL

The equipment shall be used for detecting different types of defects in Gas Insulated Stations (GIS) such as Particles, Loose shields and Partial Discharges as well as for detection of Partial discharges in other types of equipment such as Cable Joints, CTs and PTs.

1.1 It shall be capable for measuring PD in charged GIS environment as EHV which shall have bandwidth in order of 10 KHz – 500 KHz with possibility to select a wide range of intermediate bandwidths for best measurement results. The principal of operation shall be on acoustic technique and the method of measurement shall be non-intrusive. The instrument is able to detect partial discharges in cable joints, terminations, CTs and PTs etc., with the hot sticks.

1.2 Detection and measurement of PD and bouncing particles shall be displayed on built in large LCD display and the measurement shall be stored in the instrument and further downloadable to a PC for further analysis to locate actual source of PD such as free conducting particles, floating components, voids in spacers, particle on spacer surfaces etc.

2.0 TECHNICAL SPECIFICATION:

Measurement shall be possible in noisy environment.

Stable reading shall be possible in presence of vibrations within complex GIS assemblies, which can produce signals similar to PD.

Equipment should have necessary synchronizing circuits to obtain PD correlation with power cycle and power frequency.

The equipment shall be battery operated with built-in-battery charger. It shall also be suitable for 230V AC/50 Hz input.

Measurement shall be possible in the charged switchyard in the presence of EMI/EMC. Supplier should have supplied similar detector for GIS application to other utilities. Performance certificate and the list of users shall be supplied along with the offer.

Instrument shall be supplied with standard accessories i.e., re-locatable sensors with mounting arrangements, connecting cables (duly screened) to sensors, Lap-top PC, diagnostic software, carrying case, rechargeable battery pack with charger suitable for 230V AC, 50Hz supply connecting cables (duly screened) to view in storage.

The function of software shall be covering the following:

- Data recording, storage and retrieval in computer
- Data base analysis
- Template analysis for easy location of fault inside the GIS
- Evaluation of PD measurement i.e, Amplitude, Phase Synchronization etc.
- Evaluation of bouncing/loose particles with flight time and estimation on size of particle.
- Report generation
To prove the suitability in charged switchyard condition, practical demonstration shall be conducted before acceptance.

Supplier shall have “Adequate after sales service” facility in India.

Necessary training may be accorded to personnel to make use of the kit for locating PD sources inside the GIS.

Instrument shall be robust and conform to relevant standard.

### TABLE-I

**REQUIREMENTS FOR 245 kV CURRENT TRANSFORMER**

<table>
<thead>
<tr>
<th>No. of cores</th>
<th>Core No.</th>
<th>Application</th>
<th>Current ratio</th>
<th>Output Burden (VA)</th>
<th>Accuracy Class as Per IEC: 44-1</th>
<th>Min. Kneept. Voltag e Vk</th>
<th>Max. CT Sec. Wdg. Resistan ce (ohm)</th>
<th>Max. Excitation Current Vk (in mA)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>BUS DIFF CHECK</td>
<td>1600-800/1</td>
<td></td>
<td>1600/800</td>
<td>8/4</td>
<td></td>
<td>25 on 1600/1 tap 50 on 800/1 tap</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>BUS DIFF MAIN</td>
<td>1600-800/1</td>
<td></td>
<td>1600/800</td>
<td>8/4</td>
<td></td>
<td>25 on 1600/1 tap 50 on 800/1 tap</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>METERING</td>
<td>1600-800/1</td>
<td>20</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>TRANS BACK UP/LINE PRTN</td>
<td>1600-800/1</td>
<td></td>
<td>1600/800</td>
<td>8/4</td>
<td></td>
<td>25 on 1600/1 tap 50 on 800/1 tap</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>TRANS DIFF/ LINE PRTN</td>
<td>1600-800/1</td>
<td></td>
<td>1600/800</td>
<td>8/4</td>
<td></td>
<td>25 on 1600/1 tap 50 on 800/1 tap</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:-**
• The Bidder will ensure compatibility of CT and numerical relay in respect of knee-point voltage as well as operating time of relay to avoid mal-functioning or damage to the numerical relay.

**TABLE-II**

**REQUIREMENT OF 220kV VOLTAGE TRANSFORMERS**

<table>
<thead>
<tr>
<th>Sl.</th>
<th>PARTICULARS</th>
<th>220kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rated primary voltage</td>
<td>245/√3 kV</td>
</tr>
<tr>
<td>2</td>
<td>Type</td>
<td>Electromagnetic</td>
</tr>
<tr>
<td>3</td>
<td>No. of secondaries</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Rated voltage factor</td>
<td>1.2 continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5-30 seconds</td>
</tr>
<tr>
<td>5</td>
<td>Phase angle error</td>
<td>±20 minutes</td>
</tr>
<tr>
<td>6</td>
<td>Rated voltage (V)</td>
<td>110/√3</td>
</tr>
<tr>
<td>7</td>
<td>Application</td>
<td>Protection</td>
</tr>
<tr>
<td>8</td>
<td>Accuracy</td>
<td>3P</td>
</tr>
<tr>
<td>9</td>
<td>Output burden (VA) (minimum)</td>
<td>50</td>
</tr>
</tbody>
</table>

**29.0 DOCUMENTS, DATA DRAWINGS AND ENGINEERING CO-ORDINATION PROCEDURE.**

29.1 GIS equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required ensuring a completely engineered GIS substation shall be provided in respect of mechanical, electrical, control & instrumentation, civil & structural works as per the scope.

29.2 Vendor shall furnish engineering data/drawings and manuals in accordance with the schedule of information as specified in Technical Specification and data sheets.

The number of copies/prints/floppy discs/CD-ROMs/manuals to be furnished for various types of documents is given in Annexure-I of this Section. In addition to numbers indicated, 2 sets of each of drawings & 1 set CD/Floppies shall also be furnished.

29.3 The documentation that shall be provided by the Vendor is indicated in the various sections of specification. This documentation shall in general include (whichever applicable for the package) but not be limited to the following as mentioned below.

29.4 Detailed Engineering Documents

i) General layout

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the plant.
iii)

vi) Technical data sheets for all bought out and manufactured items. Vendor shall use the technical specifications as a base for placement of orders on their sub-vendors.

vii) Detailed design calculations for components, system, wherever applicable.

viii)

xi) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

xii) Protection system diagrams and settings.

xiii) Cables schedules and interconnection diagrams.

xiv) Cable routing plan.

xv) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xvi) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xvii) Sequence and protection interlock schemes.

xviii) Type test reports.

xix) Control system configuration diagrams and card circuit diagrams and maintenance details.

xx) Detailed software manuals & source software listing.

xxi) Detailed flow chart for digital control system.

xii) Mimic diagram layout.

xxiii) Civil drawings for architectural works, foundations and super-structural works, Civil calculation sheets including structural analysis and design along with output results.

xxvii) Functional & guarantee test procedures and test reports.

xxviii) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.
Vendor's while submitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

5.5 Instruction Manuals

Vendor shall submit to EPI, draft Instruction Manuals for all the equipments and as well as for the complete system covered under the Contract within the time agreed upon between EPI and the Vendor. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project.

The Instruction Manuals of plant / equipment / system shall comprise of the following:

i) Erection Manuals

The erection manuals shall be submitted at least three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipments like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection.

h) General safety procedures to followed during erection/installation.

i) Procedure for initial checking after erection.

j) Procedure for testing and acceptance norms.

k) Procedure / Check list for pre-commissioning activities.

l) Procedure / Check list for commissioning of the system.

m) Safety precautions to be followed in erection all equipments and electrical supply distribution during erection.

ii) Operation & Maintenance (O & M) Manuals.

a) The manual shall be a two rim PVC bound stiff sided binder able to withstand
constant usage or where a thicker type is required it shall have locking steel pins, the size of the manual shall not be larger than international size A3. The cover shall be printed with the Project Name, Services covered and Volume / Book number each section of the manual shall be divided by a stiff divider of the same.
size as the holder. The dividers shall clearly state the section number and title. All written instructions within the manual not provided by the manufacturers shall be typewritten with a margin on the left hand side.

b) The arrangement and contents of O & M manuals shall be as follows:

1) Chapter 1 - Plant Description: To contain the following sections specific to the equipment/system supplied

   (a) Description of operating principle of equipment / system with schematic drawing / layouts.

   (b) Functional description of associated accessories / controls. Control interlock protection writeup.

   (c) Integrated operation of the equipment along with the intended system. (The is to be given by the supplier of the Main equipment by taking into account the operating instruction given by the associated suppliers).

   (d) Exploded view of the main equipment, associated accessories and auxiliaries with description. Schematic drawing of the equipment along with its accessories and auxiliaries.

   (e) Design data against which the plant performance will be compared.

   (f) Master list of equipments, Technical specification of the equipment/ system and approved data sheets.

   (g) Identification system adopted for the various components, (it will be of a simple process linked tagging system).

   (h) Master list of drawings (as built drawing - Drawings to be enclosed in a separate volume).

2) Chapter 2.0 - Plant Operation: To contain the following sections specific to the equipment supplied

   (a) Protection logics provided for the equipment along with brief philosophy behind the logic, Drawings etc.

   (b) Limiting values of all protection settings.
(c) Various settings of annunciation/interlocks provided.

(d) Startup and shut down procedure for equipment alongwith the associated systems in step mode.

(e) Do's and Don'ts related to operation of the equipment.

(f) Safety precautions to be take during normal operation. Emergency instruction on total power failure condition/lubrication failure/any other conditions.

(g) Parameters to be monitored with normal value and limiting values.

(h) Equipment isolating procedures.

(i) Trouble shooting with causes and remedial measures.

(j) Routine testing procedure to ascertain healthiness of the safety devices alongwith schedule of testing.

(k) Routine Operational Checks, Recommended Logs and Records

(l) Change over schedule if more than one auxiliary for the same purpose is given.

(m) Preservation procedure on long shut down.

(n) System/plant commissioning procedure.

3) Chapter 3.0 - Plant Maintenance: To contain the following sections specific to the equipment supplied.

(a) Exploded view of each of the equipments. Drawings alongwith bill of materials including name, code no. & population.

(b) Exploded view of the spare parts and critical components with dimensional drawings (In case of Electronic cards, the circuit diagram to be given) and spare parts catalogue for each equipment.
(c) List of Special T/P required for Overhauling /Trouble shooting including special testing equipment required for calibration etc.

(d) Stepwise dismantling and assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained etc. Clearance to be maintained etc.

(e) Preventive Maintenance schedules linked with running hours/calendar period alongwith checks to be carried out.

(f) Overhauling schedules linked with running hours/calendar period alonwith checks to be done.

(g) Long term maintenance schedules

(h) Consumables list alongwith the estimated quantity required during normal running and during maintenance like Preventive Maintenance and Overhauling.

(i) List of lubricants with their Indian equivalent, Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation and quantity required for complete replacement..

(j) Tolerance for fitment of various components.

(k) Details of sub vendors with their part no. in case of bought out items.

(l) List of spare parts with their Part No, total population, life expediency & their interchangeability with already supplied spares.

(m) List of mandatory and recommended spare list along with manufacturing drawings, material specification & quality plan for fast moving consumable spares.

(n) Lead time required for ordering of spares from the equipment supplier, instructions for storage and preservation of spares.

(o) General information on the equipment such as modification carried out in the equipment from its inception, equipment population in the country / foreign country and list of utilities where similar equipments have been supplied.

7.03.03 After finalization and approval of the Employer, the O & M Manuals shall be submitted as indicated in Annexure-I. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals (both erection and O & M manuals have been supplied to EPI / Employer.

If after the commissioning and initial operation of the plant, the instruction manuals (Erection and /or O &M manuals) require modifications/additions/ changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Vendor to the EPI/Employer for records and number of copies shall be as
mentioned in Annexure-1.

7.03.04 Project Completion Report.

Vendor shall submit a Project Completion Report at the time of handing over the plant/equipment.

7.04.00 Engineering Data / Drawings

7.04.01 All data/ information furnished by Vendor in the form of drawings/ documents/catalogues or in any other form for NTPC's information/ interface and or review and approval are referred by the general term “drawings”.

7.04.02 All documents submitted by the Vendor for EPI/Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, Floppies or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval shall be in the Image form / Autocad drawing format / pdf format readable through Acrobat Reader as mutually agreed to between Vendor and EPI before award of Contract. All documents/text /calculations etc
information shall be in MS Office application such as MS – WORD or MS-Excel as the case may be.

7.04.03 All drawings submitted by the Vendor including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

7.04.04 Each drawing submitted by the Vendor (including those of sub-vendors of Vendor) shall bear a title block at the right hand bottom corner with clear mention of the name of EPI & Employer, the system designation, the specifications title, the specification number, the name of the Project, drawing number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units. A sample of ‘TITLE’ Block shall be furnished to the successful vendor.

7.04.05 The drawings submitted by the Vendor (or their sub-vendors) shall bear Employer’s drawing number wherever available in addition to Vendor’s (their sub-vendor’s) own drawing number. Employer’s drawing numbering system shall be made available to the successful Vendor so as to enable him to assign Employer’s drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

7.04.06 Vendor shall also furnish a “Master Drawing List” which shall be a comprehensive list of all drawings/ documents/ calculations envisaged to be furnished by him during the detailed engineering to EPI along with the schedule of submission of each drawing/document. Such list should clearly indicate the purpose of submission of these drawings i.e. “FOR APPROVAL” or “FOR INFORMATION ONLY”.

7.04.07 The review of these drawings by EPI/Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under specifications, external connections, and of the dimensions which might affect plant layout. This review by EPI/Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be relieve the Vendor of any of his responsibilities and liabilities under this Contract.

7.04.08 After the approval of the drawings, further work by the Vendor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of EPI/Employer.

7.04.09 All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Vendor’s risk.
7.04.10 Vendor is expected not to make any changes in the design of the equipment/system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipment/system at a later date, vendor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specification.

7.04.11 Drawings shall include all installations and detailed piping layout drawings. Layout drawings for all piping of 65 mm and larger diameter shall be submitted for review/approval of Employer prior to erection. Small diameter pipes shall however be routed as per site conditions in consultation with site authority/representative of Employer based on requirements of such piping indicated in approved/finalized Flow Scheme/Process & Instrumentation Diagrams and/or the requirements cropping up for draining venting of larger diameter piping or otherwise after their erection as per actual physical condition for the entire scope of work of this package.

7.04.12 Assessing & anticipating the requirement and supply of all piping and equipment shall be done by the contractor well in advance so as not to hinder the progress of piping & equipment erection, subsequent system charging and its effective draining venting arrangement as per site suitability.

7.04.13 Final copies of the approved drawings shall be submitted in vector form on CD-ROM long with the requisite number of hard copies as per Annexure-I.

7.04.14 As Built Drawings

After final acceptance of individual equipment/system by the Employer at the plant/site, the Vendor will update all original drawings and documents for the equipment/system to “as built” conditions.

7.04.15 All engineering data submitted by the Vendor after final process including review and approval by the Employer/Project Manager shall form part of the contract documents and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Employer / Project Manager in writing.